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(57) [Abstract]

[Problem]

To improve the correction sensitivity of a convergence

yoke to CRTs, and to realize highly precise image distortion correction and convergence correction up to the screen periphery during high-speed horizontal scanning and multiple scanning.

[Solution]

Second-set RGB vertical correction coils 15, 16 and 17 are connected in parallel to reduce the impedance as viewed from a current amplifier circuit 11 to suppress the power supply voltage of the current amplifier circuit 11. The total correction burden imposed to the convergence yoke is divided into two sets of coils to reduce the correction burden imposed to the vertical correction coils 15, 16 and 17.

[Claims]

1. A convergence correction device for use in a video display apparatus employing a cathode-ray tube, wherein a single convergence yoke core arranged on the axis of the cathode-ray tube is provided with two sets each of a horizontal correction winding for correcting horizontal convergence and a vertical correction winding for correcting vertical convergence, the horizontal correction winding and the vertical correction winding of each of the two sets being wound commonly.

2. A convergence correction device for use in a video display apparatus employing a cathode-ray tube, wherein two convergence yoke cores are arranged on the axis of the cathode-ray tube in the fore-and-aft direction thereof, each of the two convergence yoke cores being provided with a set of a horizontal correction winding for correcting horizontal convergence and a vertical correction winding for correcting vertical convergence.

3. A convergence correction device for use in a video display apparatus employing a plurality of cathode-ray tubes according to Claim 1 or 2, wherein the cathode-ray tubes are each provided with two sets of a horizontal correction winding and a vertical correction winding, and the convergence correction device comprises a drive circuit which drives the first-set horizontal correction windings and vertical correction windings separately for each of the cathode-ray

tubes, and drives the second-set horizontal correction winding and vertical correction winding commonly for the cathode-ray tubes.

4. The convergence correction device according to Claim 3, wherein the drive circuit drives the second-set vertical correction windings by a signal waveform that is obtained by modulating in parallel a parabola waveform synchronized with a horizontal scanning frequency, with a serrated waveform synchronized with a vertical scanning frequency.

5. The convergence correction device according to Claim 3, wherein the drive circuit drives the second-set horizontal correction windings by a sine waveform synchronized with a horizontal scanning frequency.

6. The convergence correction device according to Claim 3, wherein the drive circuit drives the second-set horizontal correction windings by a parabola waveform synchronized with a horizontal scanning frequency.

[Detailed Description of the Invention]

[0001]

[Technical Field]

The present invention relates to a convergence correction device for use in a video display apparatus to support a

high-speed horizontal scanning frequency.

[0002]

[Prior Art]

In recent years, the market for video display apparatuses employing a cathode-ray tube (hereafter, to be referred to as "CRT"), which are used as devices for displaying high definition video sources such as high definition television and extended definition television, or displaying character and graphic information of computers, has been expanded. Along with that growth of the market, there has been a demand for improvement in image quality of allover display screens.

[0003]

In particular, in projector-type display apparatuses using a projection CRT, the density of current applied to the CRT per unit area of an electron beam is very high. Additionally, the screen of the CRT need be enlarged greatly. Therefore, it is even more important for such projector-type display apparatuses to achieve both high focusing performance and high convergence performance over the whole screen.

[0004]

In addition, firstly as for those video display apparatuses used for high definition televisions or computer displays which are required to have highly fine display performance, emphasis is placed on ensuring of high peripheral focusing performance. Therefore, the magnetic field distribution of a deflection yoke is homogenized to reduce the spot distortion in the periphery. As a result of such design,

as shown in Fig. 5(a), pin cushion distortion is caused in the raster shape of the CRT screen, and correction is needed to cancel this distortion.

[0005]

Secondly, multiple scanning type projectors are becoming common to satisfy the requirement to enable high definition televisions and various computers having different scanning frequencies to use a single video display apparatus for the display purpose. Therefore, in view of this second requirement to provide multiple scanning support in addition to the first requirement to provide high definition, it is necessary for the display apparatus to have an image distortion correction function that is common to all the CRTs in addition to the correction function to correct color shift, or so-called convergence of the CRTs. This image distortion correction function can be realized, for example, by a convergence circuit for its easiness in realization. The convergence correction device having such correction function typically has a vertical pincushion correction function for the vertical correction and an S-shaping correction function and a linear correction function for the horizontal correction.

[0006]

A description will now be made of a conventional convergence correction device with reference to Figs. 6, 7, 8 and 9. Fig. 6(a) shows a typical configuration of a projection unit of a projector. As shown in Fig. 6(a), a deflection yoke 22 for main deflection is attached to the neck of a CRT 21. A

convergence yoke 23 is attached at the rear of the deflection yoke 22 as an auxiliary yoke for minutely deflecting a beam orbit before the deflection center of the deflection yoke 22.

[0007]

In the convergence yoke 23 as shown in Fig. 6(b), two sets of windings are wound on a convergence yoke core 27. The two sets of windings consist of an H coil 25 for horizontal convergence correction and a V coil 26 for vertical convergence correction.

[0008]

The convergence yoke 23 shown in Fig. 6(b) employs a ring-shaped core as the convergence yoke core 27, and is composed of this ring-shaped core and toroidal windings. This is an example of various configurations of convergence yokes which are now in practical use.

[0009]

A description will now be made, with reference to Fig. 7, of an example of relationship between waveforms of correction current (correction waves) supplied to the H coil 25 and V coil 26, or the horizontal and vertical corrections coils of the convergence yoke 23, and image distortion correction functions (corrective changes) obtained as a result of the current supply. In practice, the convergence correction or image distortion correction in projectors is carried out for each of RGB colors while combining the various correction functions shown in Fig. 7.

[0010]

Fig. 8 shows a typical configuration of a convergence correction device for projectors which project an image on a screen with the use of CRTs for RGB three colors. As shown in Fig. 8, a correction wave generating circuit 3 generates various types of correction waves as shown in Fig. 7 in synchronization with synchronization signals Hp1 and Vp2 of respective horizontal and vertical scanning frequencies. The various types of correction waves generated by the correction wave generating circuit 3 are input to a various correction wave synthesis and level control circuit 41. The level-controlled various correction waves are input to a current amplifier circuit 47 as synthesized waves of the various correction waves, and then applied as correction current to an R-H coil 53 that is a convergence coil for the red (to be abbreviated as "R") horizontal channel.

[0011]

There is a G-H coil 54, a B-H coil 55, a R-V coil 56, a G-V coil 57, and a B-V coil 58 as convergence coils for the channels (horizontal and vertical channels) for other colors (G and B). As in the case of the R-H coil 53, various types of correction waves are applied to these coils as correction current by various correction wave synthesis and level control circuits 42, 43, 44, 45 and 46 and current amplifier circuits 48, 49, 50, 51 and 52 corresponding to the respective colors and channels.

[0012]

Further, with reference to Fig. 9, a description will be

made of specific configuration of the various correction wave synthesis and level control circuit 41 described above with reference to Fig. 8. As shown in Fig. 9, the correction waves output from the correction wave generating circuit 3 are input to a multiplying DAC 64 if they are horizontal rate serrated waves Hsaw, for example, and an analog waveform such as that of the serrated waves Hsaw is converted, by the multiplying DAC 64, into an analog waveform Hsaw' of a level that is newly obtained by controlling the level of the serrated waves Hsaw according to a digital control signal received from a CPU 62.

[0013]

The digital control signal from the CPU 62 is output in response to a control operation of an adjusting remote controller 61. The control data, or the digital control signal is stored in an EEPROM 63 via the CPU 62 by operation of the remote controller 61 if required.

[0014]

The data stored in the EEPROM is retrieved by the CPU 62 if required. The various correction wave synthesis and level control circuit 41 as shown in Fig. 9 includes a plurality of multiplying DACs 64, 65, 66 and 67 corresponding to the types of correction waves from the correction wave generating circuit 3, and an adding circuit 68 for adding output signals from these multiplying DACs.

[0015]

[Problems to be Solved by the Invention]

However, the conventional convergence correction device

as described above has a problem that, if the horizontal scanning frequency is high and the horizontal retrace period of horizontal deflection is short or if the convergence correction amount is large, the through rate of the correction current in the convergence correction circuit during the horizontal retrace period will be restricted by the correction sensitivity of the convergence yoke to the CRT, the power supply voltage of the current amplifier circuit driving the convergence coil, or the switching speed or withstand voltage of a drive element used in the current amplifier circuit. This will cause waveform distortion at the boundary between the retrace period and the effective display period, resulting in geometric image distortion or convergence shift in the screen periphery.

[0016]

This problem becomes more serious as the horizontal scanning frequency used in the projector is increased, and as the retrace period is decreased in correspondence with the increase in the horizontal scanning frequency. Further, the problem becomes even more noticeable when the pin cushion distortion is increased as a result of homogenizing the magnetic field distribution of the deflection yoke for the purpose of increasing the definition, or when the required correction amount is increased as a result of shortening the focus of the projection lens for the purpose of shortening the projection distance of the projector.

[0017]

When used in computers, in particular, underscan display is typically used and the requirement level for the peripheral image quality is extremely high. Therefore, the problem as described above becomes even more serious.

[0018]

It is an object of the present invention to solve the problem by improving the correction sensitivity of the convergence yoke to the CRT, and realizing highly precise image distortion correction and convergence correction up to the screen periphery to satisfy the stringent performance requirement for high-speed horizontal scanning and multiple scanning.

[0019]

[Means for Solving the Problems]

In order to solve the problem, a convergence correction device of the present invention as claimed in Claim 1 is for use in a video display apparatus employing a cathode-ray tube, wherein a single convergence yoke core arranged on the axis of the cathode-ray tube is provided with two sets each of a horizontal correction winding for correcting horizontal convergence and a vertical correction winding for correcting vertical convergence, the horizontal correction winding and the vertical correction winding of each of the two sets being wound commonly.

[0020]

The convergence correction device as claimed in Claim 2 is for use in a video display apparatus employing a cathode-ray

tube, wherein two convergence yoke cores are arranged on the axis of the cathode-ray tube in the fore-and-aft direction thereof, each of the two convergence yoke cores being provided with a set of a horizontal correction winding for correcting horizontal convergence and a vertical correction winding for correcting vertical convergence.

[0021]

According to the configuration as described in Claim 1 or 2, one of the two sets of RGB correction coils are connected in parallel to reduce the impedance as viewed from the current amplifier circuit to suppress the power supply voltage of the current amplifier circuit. On the other hand, the other set of RGB correction coils are connected in series so that the impedance as viewed from the current amplifier circuit is the sum of the correction coils. Thereby, although the power supply voltage of the current amplifier circuit is increased to sum extent, the output current is suppressed low. Additionally, the correction burden imposed to the coils can be reduced by dividing the total correction burden imposed to the convergence yoke to two sets of coils.

[0022]

[Mode for Carrying Out the Invention]

A convergence correction device according to a first embodiment of the present invention will now be described with reference to Figs. 1, 2 and 3.

[0023]

As shown in Fig. 1(a), two convergence yokes, namely a

convergence yoke 23 and convergence yoke 24 are attached to the rear of a deflection yoke 22 that is arranged in the neck of a CRT 21. As shown in Fig. 1(b), each of these two convergence yokes 23 and 24 has, on its convergence yoke core (ring core) 27, an H coil 25 as a horizontal correction winding for horizontal correction and a V coil 26 as a vertical correction winding for vertical correction. Thus, each of the convergence yoke 23 and the convergence yoke 24 is provided with a set of convergence coils composed of an H coil 25 and a V coil 26. As a whole, two sets of convergence coils for the convergence yoke 23 and the convergence yoke 24 are provided.

[0024]

Further, as shown in Fig. 2(a), the convergence correction device having two sets of convergence coils may be provided with a single convergence yoke 23. As shown in Fig. 2(b), the convergence yoke core 27 is provided with two sets each of an H coil a31 and an H coil b32 as horizontal convergence coils, the windings being wound commonly on the convergence yoke core 27. The convergence yoke core 27 is further provided with two sets each of a V coil b33 and a V coil b34 as vertical correction coils, the windings also being wound commonly on the convergence yoke core 27. Alternatively, the convergence yoke core 27 may be provided with two sets of convergence coils, consisting of a set composed of an H coil a31 and a V coil a33 and another set composed of an H coil b32 and a V coil b34.

[0025]

A description will now be made, with reference to Fig.

3, on a specific configuration of the convergence correction device according to the first embodiment, which includes two sets of convergence coils as shown in Fig. 1(a), and drives these two sets of convergence coils by the convergence yokes 23 and 24 or the single convergence yoke 23 as shown in Fig. 2(a).

[0026]

In the block diagram of Fig. 3, the relationship among the correction wave generating circuit 3, the various correction wave synthesis and level control circuits 4, 5, 6 and 7 serving as drive circuits, and the current amplifier circuits 8, 9, 10 and 11 is basically similar to that of the prior art, and the detailed description thereof will be omitted.

[0027]

Operation of the convergence correction device including the components as described above will now be described with reference to Fig. 3. The description here will be made of a mutual correction function of the two sets of convergence coils shown in Fig. 3. For simplification of description, the description will first be made only of vertical correction, taking a projector employing three RGB CRTs as an example.

[0028]

A first set of vertical correction coils are composed of an R-V coil a12, a G-V coil a13, and a B-V coil a14, and correction current is applied to these coils independently. Taking the R-V coil a12 for an example, the R-V coil a12 is independently supplied with correction current through a channel composed of the generating circuit 3, the various correction wave synthesis

and level control circuit 4, and the current amplifier circuit 8. The same applies to the G-V coil a13 and the B-V coil a14.

[0029]

A second set of vertical correction coils composed of an R-V coil b15, a G-V coil b16, and a B-V coil b17 are connected in parallel. These second-set vertical correction coils 15, 16, and 17 connected in parallel are supplied with correction current from the current amplifier circuit 11. If the vertical correction coils 15, 16 and 17 have same parameters, they are supplied with same current. The same basically applies to the horizontal correction.

[0030]

A description will now be made of the correction function to the vertical correction coils 15, 16 and 17 described above. Since the second-set vertical correction coils 15, 16 and 17 can be supplied with same current, these correction coils apply correction waves enabling a common image distortion correction function to the RGB CRTs. A specific example of such correction waves is correction waves as shown in Fig. 5(b) which are obtained by modulating in parallel a parabola waveform (of a cycle 1H) synchronized with the horizontal scanning frequency with a serrated waveform (of a cycle 1V) synchronized with the vertical scanning frequency. The application of such correction waves enables correction of vertical pincushion distortion.

[0031]

Assuming that the correction coil 15, 16 and 17 serve as

coils for horizontal correction instead of vertical correction, as shown in Fig. 5(c), a sine waveform (of a cycle 1H) synchronized with the horizontal scanning frequency is used as the correction waves, and the application of such correction waves enables an S-shaping correction (linearity correction) in a horizontal direction. In some cases depending on correction conditions, a parabola waveform (of a cycle 1H) synchronized with the horizontal scanning frequency is used as the correction waves in place of the above-mentioned sine waveform.

[0032]

On the other hand, the first-set vertical correction coils 12, 13 and 14 in Fig. 3 independently apply correction waves as RGB vertical correction waves to carry out so-called color-shift correction.

[0033]

According to the configuration as described above, the total correction burden imposed on the convergence yoke is divided into two sets of coils to reduce the correction burden on each coil. Thus, the correction sensitivity of the convergence yoke to the CRT can be improved, and consequently the deficiency in the correction sensitivity can be improved. As a result, highly precise image distortion correction and convergence correction can be performed up to the screen periphery to meet the performance requirement during the high speed scanning and multiple scanning.

[0034]

A convergence correction device according to a second embodiment of the present invention will now be described with reference to Fig. 4. Similarly to the first embodiment, the description of the second embodiment is made in terms of the mutual correction function of two sets of convergence coils shown in Fig. 4. For the purpose of simplification, only the vertical correction will be described, taking a projector having three RGB CRTs as an example. The description of the second embodiment will be made only on the different features from the first embodiment.

[0035]

In the second embodiment shown in Fig. 4, the second-set vertical correction coils 15, 16 and 17 are connected in series, and are supplied with identical current, regardless of difference in parameters among the coils.

[0036]

In terms of the connection of the vertical correction coils 15, 16 and 17, the first embodiment shown in Fig. 3 is characterized in that the vertical correction coils 15, 16 and 17 are connected in parallel. Consequently, the impedance as viewed from the current amplifier circuit 11 becomes low and hence the power supply voltage of the current amplifier circuit 11 can be suppressed low. On the other hand, the second embodiment shown in Fig. 4 is characterized in that the vertical correction coils 15, 16 and 17 are connected in series, and hence the impedance as viewed from the current amplifier circuit 11 is the sum of the vertical correction coils 15, 16 and 17.

Although the power supply voltage of current amplifier circuit 11 is increased to some extent, the output current can be suppressed low.

[0037]

According to the second embodiment as described above, like the first embodiment, the total correction burden imposed on the convergence yoke is divided into two sets of coils to reduce the correction burden on each coil. Thus, the correction sensitivity of the convergence yoke to the CRT can be improved, and consequently the deficiency in the correction sensitivity can be improved. As a result, highly precise image distortion correction and convergence correction can be performed up to the screen periphery to meet the performance requirements in the high speed scanning and multiple scanning.

[0038]

Either the first embodiment or the second embodiment can be applied selectively, in view of the ratings or the like of the power source system and drive elements including other circuit blocks of the projector.

[0039]

[Effect of the Invention]

According to the present invention as described above, the correction burden imposed on the coils can be reduced by dividing the total correction burden imposed on the convergence yoke into two sets of coils.

[0040]

As a result, the correction sensitivity of the

convergence yoke to the CRT can be improved, and this makes it possible to realize highly precise image distortion correction and convergence correction up to the screen periphery to meet difficult performance requirements for high-speed horizontal scanning and multiple scanning.

[Brief Description of the Drawings]

[Fig. 1]

Fig. 1 is a schematic diagram showing a convergence yoke according to a first embodiment of the present invention.

[Fig. 2]

Fig. 2 is a schematic diagram showing another convergence yoke according to the first embodiment.

[Fig. 3]

Fig. 3 is a block diagram of a convergence correction device according to the first embodiment.

[Fig. 4]

Fig. 4 is a block diagram showing a convergence correction device according to a second embodiment of the present invention.

[Fig. 5]

Fig. 5 is an explanatory drawing of pin cushion distortion when the magnetic field distribution of the deflection yoke is homogenized.

[Fig. 6]

Fig. 6 is a schematic diagram showing a conventional convergence yoke.

[Fig. 7]

Fig. 7 is a relationship diagram between various correction waves applied to the convergence coils and raster shapes.

[Fig. 8]

Fig. 8 is a block diagram showing a conventional convergence correction device.

[Fig. 9]

Fig. 9 is a block diagram showing a various correction wave synthesis and level control circuit in the conventional convergence correction device.

[Description of Reference Numerals]

4, 5, 6, 7: Various correction wave synthesis and level control circuit

25: H coil

26: V coil

27: Convergence yoke core

31: H coil a

32: H coil b

33: V coil a

34: V coil b

Fig. 3

3: Correction wave generating circuit

4: Various correction wave synthesis and level control circuit

Fig. 4

3: Correction wave generating circuit

4: Various correction wave synthesis and level control circuit

Fig. 7

補正波 Correction wave

(1) Vertical serrated wave

(2) Vertical parabola wave

(3) Horizontal serrated wave

コーバーゼンスコイル Convergence coil

垂直 Vertical

水平 Horizontal

補正変化 Corrective change

垂直振幅 Vertical amplitude

直交補正（縦線） Orthogonal correction (vertical lines)

垂直直線性 Vertical linearity

縦線曲がり補正 Bent correction of vertical lines

直交補正（横線） Orthogonal correction (horizontal lines)

水平振幅 Horizontal amplitude

補正波 Correction wave

(4) Horizontal parabola wave

(5) Trapezoidal correction wave

(6) Vertical trapezoidal, transverse unbalanced waves

(7) Transverse trapezoidal, vertical unbalanced waves

コンバーゼンスコイル Convergence coil

垂直 Vertical

水平 Horizontal

補正変化 Corrective change

横線曲がり補正 Bent correction of transverse lines

水平直線性 Horizontal linearity

左右台形補正 Transverse trapezoidal correction

上下台形補正 Vertical trapezoidal correction

上下台形のアンバランス補正 Correction of vertical trapezoidal unbalance

左右台形のアンバランス補正 Correction of transverse trapezoidal unbalance

Fig. 8

3: Correction wave generating circuit

4: Various correction wave synthesis and level control circuit

Fig. 9

3: Correction wave generating circuit

41: Various correction wave synthesis and level control circuit

61: Remote controller

64: Multiplying DAC

68: Adding circuit

To current amplifier circuit